VANDERBILT UNIVERSITY MEDICAL CENTER

Protocol: Pediatric Fluid Resuscitation

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Applicable to
☐ VUH ☒ Children's ☐ DOT ☐ VMG Off-site locations ☐ VMG ☐ VPH ☐ Other

Team Members Performing
☐ All faculty & staff ☒ Faculty & staff providing direct patient care or contact ☒ MD ☒ House Staff ☒ APRN/PA ☒ RN ☐ LPN ☐ Other:

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I. Population:

This fluid resuscitation protocol applies to pediatric burn patients.

Total Body Surface Area (TBSA) > 10% (0-5 years old) and TBSA >15% (6-16 years old)

Estimated total body surface area (TBSA) of partial and full thickness burns is used to calculate fluid requirements. Superficial burns (1st degree) are not included in this calculation.

Depth of Burn	
Superficial (1st Degree)	Erythema; skin intact
Partial Thickness (2nd Degree)	Wet, weepy, blisters
Full thickness (3rd Degree)	White, leathery, dry

II. Calculating TBSA:

There are various methods used to estimate TBSA. For pediatric burn patients requiring resuscitation, the Lund and Browder chart is the preferred method toestimate TBSA.

Modified Lund and Browder [8]					
Area	**Birth-1yr**	**1-4yrs**	**5-9yrs**	**10-14yrs**	**15yrs**
Head	19	17	13	11	9
Neck	2	2	2	2	2
Anterior trunk	13	13	13	13	13
Posterior trunk	13	13	13	13	13
R buttock	2.5	2.5	2.5	2.5	2.5
L buttock	2.5	2.5	2.5	2.5	2.5
Genitalia	1	1	1	1	1
R upper arm	4	4	4	4	4
L upper arm	4	4	4	4	4
R lower arm	3	3	3	3	3
L lower arm	3	3	3	3	3
R hand	2.5	2.5	2.5	2.5	2.5
L hand	2.5	2.5	2.5	2.5	2.5
R thigh	5.5	6.5	8	8.5	9
L thigh	5.5	6.5	8	8.5	9
R leg	5	5	5.5	6	6.5
L leg	5	5	5.5	6	6.5
R foot	3.5	3.5	3.5	3.5	3.5
L foot	3.5	3.5	3.5	3.5	3.5

To calculate TBSA using the Lund and Browder chart, measure the affected surfaces for each body part. For example, if a 10-year-old presented with a burn to half of the left upper arm, the TBSA of burn would be 2%. The palmar method can also be use, 1%TBSA is the equivalent of one of the PATIENT'S palms (wrist crease to tip of longest finger).

III. Emergency Department (ED) Management

An incoming burn patient should have an IV pump in the bay when they arrive. If theburn size is estimated to be >10%, the following fluid rates should be started during the primary survey:

Age/Weight of Child	Initial fluid rate & type (prior to burn size calculation)
≤5 years old & <10kg	125mL/hr of D5LR
≤5 years old & >10kg	125mL/hr of LR
6-14 years old	250mL/hr of LR
>14 years old	500mL/hr of LR

During the secondary survey and in conjunction with the burn consult resident, the burn size should be calculated, and the Parkland-based fluid resuscitation rate shouldbe determined. Maintenance fluids with a dextrose source should also be started as outlined below. Urine output should be titrated per the protocol found below. If the patient will not be admitted to the PICU within 30 minutes of starting fluid resuscitation, a foley catheter should be placed in the ED as outlined below. The resuscitation protocol can be ordered via an ED order set and ins and outs should be recorded in the flowsheet in EPIC.

IV. Acuity of Patients

All critical patients and those requiring fluid resuscitation will be assigned to the PICU.TBSA and age are also taken into consideration when determining acuity. For those patients not requiring critical care, use the following guidelines to assign patients:

Appropriate Unit	
<10% TBSA	**Admit to: Burn Step Down** No IV Resuscitation: PO intake +/- MIV
>10% TBSA **≤5 years old**	**Admit to: PICU** No IV resuscitation: Place on MIV & allow age-appropriate PO intake
10-15% TBSA **>5 years old**	**Admit to: Burn Unit** No IV resuscitation: PO intake + MIV
>15% TBSA	**Admit to: PICU** Resuscitation: Initiate fluids based on Burn Resuscitation formula (+MIV & place NJ feeding tube)

V. Patients requiring resuscitation

STEP ONE: Calculate Fluid Requirements

Resuscitation Volume + Maintenance IV Fluids = UOP goals

Maintenance Fluid- Are Not titrated D5NS

at weight-based rate (4-2-1)

Tube feeds + IV = Maintenance fluid rate.

Discontinue MIV once TF are at goal or = to volume of MIV rate.

Tube feeds should be initiated upon admission to PICU if feasible. Feeds should onlybe held for OR sedation per VCH existing policies (see Burn Nutrition Guidelines).
Any prolonged or unnecessary feeding interruption could potentiate stress ulcersand post-burn gastropathy, contribute to nutritional deficiencies, and impair recovery.

If patient requires low doses of vasoactive medications to support blood pressure until resuscitation is adequate, consider tube feeds at a trophic rate (0.5 mL/kg/hr).

Initial Resuscitation Fluid- Titrated hourly

<10kg= D5LR

>10kg= LR

STEP TWO: Identify Urinary Output Goals

< 30kg, goal UOP = 1.0 mL/kg/hr
>30kg, goal UOP = 0.5 mL/kg/hr
If myoglobinuria or rhabdomyolysis, goal UOP= 2ml/kg/hr

STEP THREE: Calculate Resuscitation Volume Hourly [1]

The following consensus formula is used for resuscitation. Resuscitation starting rate begins at 3mL/kg/%TBSA burn (see formula below) and is titratedhourly based on UOP.

Initial Resuscitation Volume Calculations [9]	
< 14 years old	**3**mL x_____kg x_____TBSA =_____mL/16=_____mL/hr
14 years old or older	**2**mL x_____kg x_____TBSA =_____mL/16=_____mL/hr

Example: For a 20 kg child with a TBSA burn size of 50% the starting resuscitation fluidswould be:

3 mL x 20 kg x 50% TBSA = 3000 mL
(Note: this is how much resuscitation fluid should be given in a 24-hour period)

Because more fluid is needed initially in the resuscitation, we will divide the 24-hour fluid by 16 (an accelerated rate) to calculate the initial resuscitation fluid rate)

3000 mL/16 = 187 mL/hr as a starting rate

Resuscitation volume is titrated ↑ or ↓ hourly based on UOP [2]. Hourly volumes aretitrated using resuscitation fluid only. Maintenance fluids + tube feeds should remain at the weight-based rate and are not titrated.

Standard Titration (Resuscitation Fluid Only)							
Hourly UOP	**No UOP**	**1-50% goal** *Multiply goal x0.01-0.5	**50-75 % goal** *Multiply goal x0.5-0.75	**75-125% goal** *Multiply goal x 0.75-1.25	**125-150% goal** *Multiply goal x 1.25-1.5	**150-200% goal** *Multiply goal x1.5-2	**>200% goal** *Multiply goalx 2
Resuscitation Fluid Titration	**↑ 30%** *Multiply current rate x 1.3	**↑ 20%** *Multiply current rate x1.2	**↑ 10%** *Multiply current rate x1.1	**No change**	**↓10%** *Multiply current rate x 0.9	**↓20%** *Multiply current rate x0.8	**↓30%** *Multiply current rate x0.7

VI. Difficult Resuscitation [3, 4]

If resuscitation volume is at rate of 6 mL/kg/TBSA and UOP goal is not met, notifythe PICU attending who, with consultation with the Burn Team, should assist in reassessing the following:

- Is the TBSA greater than initially estimated?
- Is there another driver for increased fluid requirements? (Inhalation injury, compartment syndrome, deep burns)

Difficult Resuscitation Calculations	
6 mL/kg/TBSA	Consider initiating albumin protocol when resuscitation volumes ≥ this rate.
	6mL x_____kg x_____TBSA =_____mL/16 =_____mL/hr
4 mL/kg/TBSA	Discontinue albumin protocol when fluids return to this rate.
	4mLx_____kg x_____TBSA =_____mL/16 =_____mL/hr

Albumin Start- If the decision is made to administer albumin, it is considered a proportion of the hourly resuscitation volume. Resuscitation fluid totals are 2/3 crystalloid and 1/3 5% albumin. Continue to titrate IV fluids hourly per UOP, each new rate if fluids will maintain the proportions of 2/3 crystalloid and 1/3 albumin. Maintenance fluids remain at weight-based rate. Albumin infusion is the preferredmethod of administration, but boluses may be used if deemed appropriate after discussion with the burn surgery attending.

Example:

Current resuscitation fluids: 200mL LR/hr.
Resuscitation fluid breakdown with starting Albumin: 134 mL/hr LR and 66mL/hr 5% Albumin

Albumin Stop- When the total rate of hourly fluid administration returns to 4 mL/kg/TBSA, albumin administration should be discontinued. When albumin is discontinued, the resuscitation fluid returns to all crystalloid fluids just as was usedatthe initiation of the protocol.

Example:

Current resuscitation fluids= 100 mL LR and 50 mL albumin/hr Stop albumin and decrease resuscitation by 10%= LR at 135 mL/hr

VII. Resuscitation End Points [5]

Resuscitation fluids are continued until oral or enteral intake is sufficient to maintain adequate UOP goals. *Resuscitation should not be stopped without a discussion with the PICU and Burn Teams*.

Note: Fluids should only rarely be completely stopped on a patient that has not had their full thickness burn excised as they will have an ongoing inflammatory responsethat will cause capillary leak and relative intravascular hypovolemia. In addition, fluid resuscitation may need to be restarted if urine output goals are not achieved and the patient has not undergone full excision.

VIII. Monitoring

Output

Output should be strictly monitored in all patients. Foley catheters will be placed in those patients requiring resuscitation with hourly titrations. *A foley catheter should be placed within 30 minutes of starting the resuscitation.* The initial output (urine that drains in the first 5 minutes after placement) should be recorded but it should not be counted as an hourly urine output, the first hour starts at time of foley placement, afterinitial output. *Forthose patients not undergoing fluid resuscitation, consideration shouldbe given to foley placement if the patient is unable to spontaneously void ≥ 4 consecutive hours during the acute phase*. See fluid management algorithm.

Hypotension

Parameters for treating hypotension and threshold of minimum blood pressure must be based on norms for the patient's age. Weight based fluid boluses (10 mL/kg) is the preferred method of management for hypotension in the resuscitationphase. *If a bolus isgiven for hypotension, the hourly fluid rate should be increased by10% at the same time*. Administration of vasopressors during the resuscitation phase is discouraged as the cause is continued hypovolemia. Vasoactive medications also cause cutaneous vasoconstriction and can extend the depth of the burn injury and worsen multi-organ failure.

Note: Fluid boluses are not calculated in resuscitation fluids and should be given for hypotension independent of fluid volume used to calculation titration.

Identifying hypotension in a burn patient requires a comprehensive clinical assessment. Hypotension in the burn patient is not well correlated with low UOP and tachycardia. Noninvasive blood pressure measurements may also be inaccuratewhen tissue edema is present. Consideration should be given to arterial line placement in high volume resuscitations. True hypotension will usually correlate with decreased UOP. However, fluid boluses are contraindicated for the management of low UOP in the hemodynamically normal patient. Hourly titrations of resuscitation volume typically correct oliguria.

IX. Complications of Resuscitation

Hypothermia

"Children have nearly three times the body surface area (BSA) to body mass ratio ofadults. Fluid losses are proportionately higher in children than in adults.
Consequently, children have relatively greater fluid resuscitation requirements andmore evaporative water loss than adults" [10]. The BSA to body mass ratio also predisposes children to rapid shifts in body temperature. Children should be monitored closely for hypothermia during the resuscitation. Interventions to maintain body temperature may include heat lamps, Bair Huggers, + warming blanket (cooling blanket but set to warm), purple gel heat packs from NICU, increased room temperature and/or fluid warmers.

Stress Ulcers [6, 7]
Patients with >20% TBSA are at risk for stress ulcers and should receive H2 blocker for routine prophylaxis beginning at admission. Early initiation of enteral feedings isalso recommended. See Pediatric Burn Nutrition Protocol.

Compartment Syndrome

Those patients receiving high-volume resuscitations are at risk for developing abdominal, ocular, and extremity compartment syndrome. Hallmarks of abdominal compartment syndrome include increased pulmonary peak and plateau pressures, decreased UOP, hypotension not responsive to volume administration, and feeding intolerance. Clinical suspicion is critical in the diagnosis of this process as no one diagnostic test is predictive. *If there is suspicion of abdominal compartment syndrome, hold feeds, obtain a bladder pressure, KUB, lactate, notify burn attending,and consult pediatric surgery immediately. Burn surgery and pediatric surgery will confer on best next steps.*

Regarding extremity compartment syndrome, *in patients requiring large volume resuscitation, extremities should be elevated at time of admission and a neurovascular exam of each extremity should be performed hourly*. Tightness of the extremity +/- loss of pulse or decreased capillary refill should be relayed to the burn
attending immediately.

Patients requiring formal volume resuscitation who are unable to communicate (either due to age or critical illness), need an ophthalmology consult at time of admit for serial measurement of intraocular pressures. Elevated pressures should prompt alateral canthotomy to prevent long-term loss of vision.

X. References

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